REMARKS

Claims 1-3 and 5 were pending in the application. In the Office Action mailed January 7, 2008, claims 1-3 and 5 are rejected. In the instant Amendment, claims 1-3 have been amended, and new claims 6-8 have been added. Upon entry of the instant Amendment, claims 1-3 and 5-8 will be pending.

Claims 1 and 2 have been amended to recite that the pins have a diameter of 10 to 30 mm. Support for the amendment is found in the specification, e.g., at page 12, line 30 through page 13, line 8; page 14, lines 1 to 9; and examples 1-7 and 21-25 (Table 2 at page 16 and Table 4 at page 19). Claims 1-3 have been amended to clarify that the ultrasonic treatment makes an average of longitudinal axis of crystal grains to a depth of at least 2 mm from the surface of the steel plate the desired size. Support for the amendment is found in the specification at, e.g., page 4, lines 3-16.

Support for new claims 6-8 is found in the specification, e.g., at page 6, lines 28-35.

No new matter has been added by these amendments. Entry of the amendments and remarks presented herein is respectfully requested.

Rejection under 35 U.S.C. § 103

Claims 1-3 and 5 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,338,765 to Statnikov ("the '765 patent") in view of S. Statnikov, Guide for Application of Ultrasonic Impact Treatment Improving Fatigue Life of Welded Structures, IIW/IIS - Document XI 11-1 757-99, International Institute of Welding, 1999, p. 1 -29, ("the IIW publication"). This rejection, as applied to the amended claims, is respectfully traversed.

The presently claimed invention provides a method for improving the toughness of a steel joint by subjecting a last pass heat affected zone (HAZ) to impacts by an ultrasonic vibration tool using one or more pins having a diameter of 10 to 30 mm to thereby make an average of the longitudinal axis of crystal grains to a depth of at least 2 mm of the heat affected zone equivalent to the crystal grain size of the steel plate matrix before the welding (*see*, the specification at p. 6, ll. 18-28; p. 7, l. 36 through p. 8, l. 20). As Figs. 1 and 3 of the present application show, in the present invention, the indenter act on the HAZ (identified as

5 in the figures). Fig. 2 of the present application shows that the presently claimed method modifies the grain structure in the HAZ. Applicants have discovered that the grain structure of the HAZ becomes coarse due to heat input of the welding (*see*, the specification at p. 6, ll. 10-17; see also Table 2, column entitled "Crystal grain size of HAZ microstructure at last pass"), which causes the toughness of the welded joint to decrease. Applicants have also discovered that by using an ultrasonic vibration tool with one or more pins having a diameter of 10 to 30 mm, the modification of microstructure in HAZ to a depth of at least 2 mm is achieved, which in turn significantly improves the toughness of the joint (*see*, Table 2, last two columns, comparing inventive examples 1-7 and comparative examples 8-14). Applicants have found that improvement of toughness is insufficient if the depth of grain structure modification is less than 2 mm (see, the specification at page 8, ll. 5-7).

The '765 patent teaches a method of utilizing ultrasonic treatment to improve the grain structure and residual stress patterns (*see*, col. 5, ll. 52-56). First, Applicants respectfully submit that the '765 patent does not teach or suggest application of ultrasonic treatment to a HAZ to improve its toughness. As discussed above, the HAZ is a region adjacent to the weld as illustrated in Figs. 1 and 3 of the present application as **5**. In contrast, the'765 patent teaches application of ultrasonic treatment to any work product.

Additionally, although the'765 patent teaches that ultrasonic treatment may result in a modified grain structure known as a "white layer" (*see*, col. 14, ll. 15-31), the'765 patent teaches that "[t]ypically a resulting white layer metallic grain structure gradient is observable at depths of 100 micrometers from the external surfaces abutting a zone of redistributed and relaxed residual stress patterns typically to depths of 3 to 12 mm." *See*, col. 17, ll. 49-52. The '765 patent also teaches that in its process, pulsed forces lead to plastic deformation on the treated work body surface and its internal body volume with penetration up to 3 mm in the steel (effect (a)), which causes additional effects such as those listed in (b)-(e) up to 12 mm in the steel (see, the '765 patent at col. 6, ll. 23-43). Neither plastic deformation nor any of the effects of (b)-(c) is a modification of sizes of crystal grains. Thus, the '765 patent clearly distinguishes modification of grain structure from other effects such as relaxation of stress, and specifically teaches that while such other effects of its ultrasonic treatment may reach 3-12 mm from the surface, modification of the grain structure only reaches a depth of 100 micrometers.

It is of interest to note that the '765 patent teaches that its effects are achieved "when stroking impulses of *appropriate stroke magnitudes and energy content* are used" (the '765 patent at col. 6, ll. 26-27; emphasis added). The indenter diameter affects at least the energy content, since for the same stroke magnitude and frequency, the larger the indenter diameter, the higher the energy content. Thus, the presently claimed invention, by using indenters having a large diameter of 10-30 mm (see below for a detailed discussion of the indenter diameter), achieves at least higher impact energy when compare to the method of the '765 patent. According to the teachings of the '765 patent, due to at least the higher impact energy, the method of the presently claimed invention can be expected to achieve effect that is different from those of the '765 patent.

Therefore, even assuming that the ultrasonic treatment taught by the '765 patent may be applied to a HAZ, the '765 patent does not teach or suggest an ultrasonic treatment having the appropriate energy content to modify the grain structure in the HAZ to a depth of at least 2 mm. The '765 patent does not teach or suggest that modification of the grain structure to such a depth is critical to improve the toughness of the HAZ. The '765 patent does not teach or suggest to make an average of longitudinal axis of crystal grains in the HAZ equivalent to the crystal grain size of the steel plate matrix before the welding at a depth of 1/4 of the thickness t from the surface of the steel plate.

In the Office action, although the Examiner acknowledges that the '765 patent does not disclose or suggest the diameter of one or more indenter pins (*see*, page 4 of the Office Action), the Examiner cites the IIW publication for disclosing on page 7 the indenter diameter of about 2-5 mm, which overlaps the previously recited range of diameters of the indenter at the lower bound. Applicants have amended the claims to recite indenter pins having a diameter of 10 to 30 mm. Nonetheless, the IIW publication teaches application of ultrasonic treatment to access the weld toe rather than the HAZ. Applicants respectfully direct the Examiner's attention to Fig. 1 or 3 of the present application for the difference between the weld toe region in a weld joint, which is identified in the figures as **10**, and the HAZ in a weld joint, which is identified in the figures as **5**. For its purpose of accessing the weld toe, the IIW publication teaches using an indenter having a diameter much smaller than that used in the present invention. For example, the IIW publication teaches that the indenter diameter should be 1-2 mm and indenters 3 mm in diameter should have taper sharpening to 1-2 mm to ensure access to the weld toe which exhibit sharp transition (*see*, e.g., the IIW

publication at p. 15, the paragraph of Section 7.9). IIW publication does not teach or suggest selecting indenter diameter to achieve modification of grain size in a HAZ, much less to a depth of 2 mm so as to improve the toughness of the welded joint. Therefore, the IIW publication not only would not have led a person skilled in the art to modify the '765 patent with indenters having diameters of 10-30 mm and to treat the HAZ, but also would have led he/she in the opposite direction of using a sharp indenter, e.g., an indenter having a diameter of 1-2 mm, and to treat the weld toe.

Thus, neither the '765 patent nor the IIW publication recognizes the problem of decrease of toughness in a last pass HAZ, much less teaches or suggests a method of solving the problem using ultrasonic treatment with a large diameter indenter. For at least the above reasons, applicants request reconsideration and withdrawal of the rejection to claims 1-3 and 5 under 35 U.S.C. § 103(a) over the '765 patent in view of the IIW publication.

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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